Phase Behavior Study of Model Asphaltene/Toluene/CO_2 Systems

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Gas injection has proved to be effective for oil recovery enhancement. Carbon dioxide injection is one of the most successful examples which is gaining more popularity. However, such a process results in changes in pressure, temperature, and composition of reservoir fluids which in turn causes asphaltene molecules to destabilize and precipitate. Therefore, understanding the phase behaviour of systems containing asphaltenes is very important for the thermodynamic and dynamic modeling of asphaltene deposition in porous media. On the other hand, the complexity of asphaltene molecular structure makes it difficult to study the phase behavior. Moreover, various asphaltenes can be obtained depending on the precipitation method that is used for extraction. Here, Violanthrone-79 and hexa-tert-butylhexa-peri-hexabenzocoronene were chosen as the model asphaltenes. These molecules have been found to have specific properties similar to the properties of asphaltenes, including molecular mass, aromaticity, naphthenic character, heteroatom content, and nature of functional groups. The experimental model oil consists of toluene and the model asphaltene with a constant asphaltene mass fraction of 0.0034 on CO_2- free basis. The experiments were carried out according to the synthetic method using a Cailletet apparatus. The phase transitions from liquid-vapor to liquid, from solid-liquid-vapor to liquid-vapor (onset of asphaltene precipitation) and from solid- liquid to liquid were determined in a temperature range of 295-365 K and in a pressure range of 0.1-11 MPa. Thereby, different amounts of carbon dioxide were added to the model oil as a precipitant. It was found that the CO_2 concentration affects the stability of the asphaltenic model oil solution. The precipitation of solid started at concentration of 50 mass % CO_2 and 30 mass % CO_2 for Violanthrone-79 and hexa-tert-butylhexa-peri-hexabenzocoronene systems, respectively.